

H I L G A R D I A

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TEXANANUS INCURVATUS

I. TAXONOMY¹

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Texananus incurvatus was described by Osborn and Lathrop⁴ as a species of *Phlepsius* in 1923. In 1939 and again in 1944, the genital structures of the species were illustrated and its occurrence in Mexico discussed (DeLong, 1939, 1944). The present description is based on specimens collected in Solano County, California. The genital structures on these specimens proved to be identical with those on Mexican specimens.

Characters. In form and general appearance, *Texananus incurvatus* resembles *neomexicanus* and a few other species but can easily be distinguished from them by the internal genital structures of the males. The distinguishing characters of this species are shown in figure 1.

This is a rather small species with a bluntly angled vertex and with brown mottling. The length is 5.5 to 7.5 mm.

The vertex (fig. 1, A) is more than one and one half times as wide between the eyes at the base as the median length. It is distinctly produced but bluntly angled.

The vertex, pronotum, and scutellum are cream-colored with a few brownish markings. In well-marked specimens, there are four mottled areas appearing as indefinite spots on the anterior portion just above the margin. Two of these are proximal and are on either side of the apex; a smaller and more indistinct area is just inside of each ocellus. A very small but darker spot is on either side at the base. The pronotum is indefinitely mottled with brown, which is heavier along the anterior margin. The scutellum is cream to yellow, with darker areas in the basal angles. The elytra are pale, almost milky white, with the veins dark brown or black, and with brown pigment lines typical of the marking of the species of this genus. The markings are irregular, leaving paler areas, the most conspicuous of which are the three lobes along the commissural line. The face is rather heavily infuscated, particularly just beneath the margin.

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⁴ See "Literature Cited" for citations, referred to in the text by author and date.

The seventh sternite of the female (fig. 1, *B*) is broadly, deeply, concavely rounded almost to the base of the segment. Portions of the preceding segment are visible at either side of the base of the concavity.

The male plates (fig. 1, *D*) are triangular and pointed at the apex. These are exceeded by the pygofer, which extends about half the length of the plates beyond their apices. The styles (fig. 1, *C*) are rather broad, deeply, roundedly excavated near their apices to form long, fingerlike processes which curve from the inner apical margin of the style and are directed outwardly. The aedeagus is rather short and is horseshoe-shaped, with the toe of the

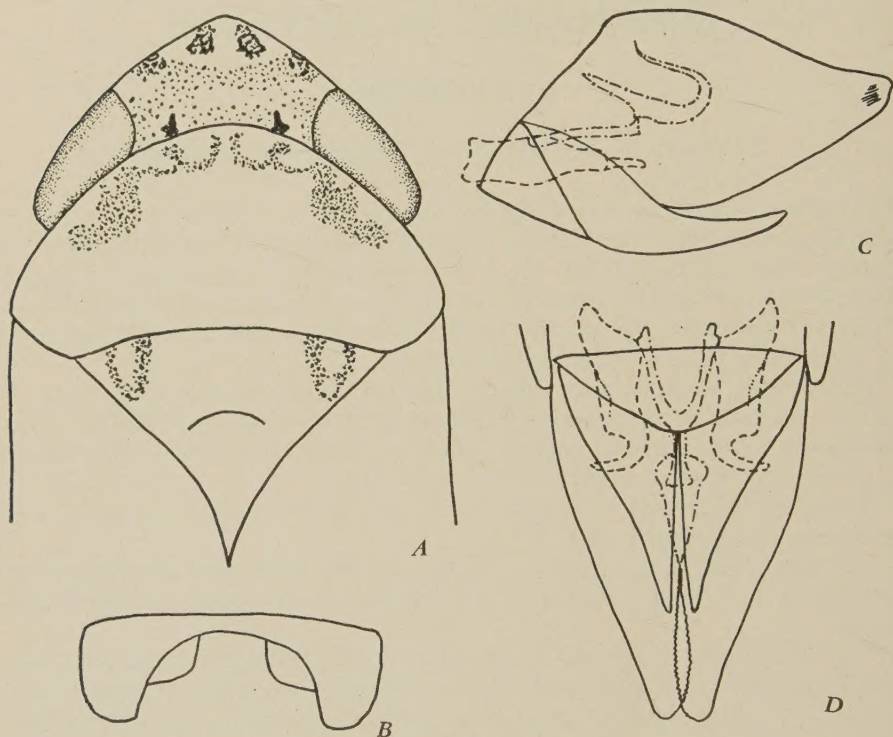


Fig. 1. *Texananus incurvatus*: *A*, head, pronotum, and scutellum, dorsal view; *B*, female seventh sternite, ventral view; *C*, male genital structures, lateral view; *D*, male genital structures, ventral view.

shoe caudal. The apex is tapered and pointed. The base is thickened at the point of attachment to the connective, then is tapered basally beyond this point.

Geographic Range. This species is known to occur in portions of Arizona, California, and the northwestern portion of Mexico. It has already been recorded for the states of Sonora and Jalisco, Mexico.

Distribution and California Food Plant. A single female of *Texananus incurvatus* was collected on alkali heath, *Frankenia grandiflora*, on October 11, 1946, on Mare Island, Solano County, by H. H. P. Severin.

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TEXANANUS INCURVATUS

II. TRANSMISSION OF CALIFORNIA ASTER-YELLOWS VIRUS¹

HENRY H. P. SEVERIN

In 1945, six leafhopper species of the phlepsid group were reported as vectors of the California aster-yellows virus (Severin, 1945). *Texananus incurvatus* is a newly discovered vector of the virus and represents the seventh phlepsid leafhopper. In a companion paper (DeLong and Severin, 1950), the taxonomy is discussed.

An investigation was undertaken on the transmission of the California aster-yellows virus to celery and asters by single males and females, and on the retention of the virus by single adults.

TRANSMISSION OF VIRUS TO CELERY AND ASTERS

By Single Males and Females. The efficiency of the vector in transmitting the virus to healthy celery or asters was determined with 100 males and 100 females, each kept singly on a healthy plant. The males and females completed the nymphal stages on diseased celery plants, requiring an average of 48.5 and 50.3 days, respectively. Each leafhopper was kept on a healthy celery plant or aster until symptoms of the disease developed, or during adult life if no symptoms developed. The virus was transmitted to healthy celery by 9 males and 12 females, or 22 per cent, and to asters by only 1 female.

RETENTION OF VIRUS BY SINGLE ADULTS

Virus retention was determined with single males and females that had transmitted virus in tests of vector efficiency. Each leafhopper, after producing the first infection, was transferred daily to healthy celery, during its adult life. The results appear in table 1.

TABLE 1

RETENTION OF VIRUS BY SINGLE ADULTS OF *TEXANANUS INCURVATUS*
WITH CELERY AS THE HOST PLANT

Insect no. and sex	Days on first plant before symptoms developed	Plants inoculated after initial infection	Plants infected after initial infection	Days after initial infection on which successive infections occurred	Longevity of adults, days
No. 1, male.....	17	28	2	4, 22	45
No. 2, male.....	15	39	1	11	54
No. 3, female.....	31	48	2	9, 29	79
No. 4, female.....	32	58	1	44	90

¹ Received for publication July 6, 1948.

Two males retained the virus from 11 to 22 days, and two females from 29 to 44 days. The period before symptoms developed on the first celery plant is not included in virus retention, since the adults were able to acquire the virus again. One male and one female produced only the initial infection in celery.

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TEXANANUS INCURVATUS

III. LIFE HISTORY

ON VIRUS-INFECTED AND ON HEALTHY PLANTS¹

HENRY H. P. SEVERIN

The duration of the nymphal stages of leafhopper species on virus-infected and on healthy plants is discussed in two recent papers (Severin, 1946, 1950). A similar study was made of the total duration of the nymphal stages of *Texananus incurvatus* on healthy celery and on celery infected with California aster-yellows virus.

Oviposition. The eggs of *Texananus incurvatus* are deposited in a row in slitlike egg chambers in the petiole of celery. After inserting the egg in the petiole, the female secretes a liquid (which becomes white when dry) in the form of threadlike papillae over each egg puncture.

Egg Period. The egg periods of *Texananus incurvatus* were determined with eggs deposited in the petioles during July and August. Each female at the egg-laying stage was confined for 1 day in a cage enclosing a large celery plant. The egg periods required from 18 to 25 days under greenhouse conditions.

Duration of Nymphal Stages. The interval or period between molts (stages or stadia), and the total duration of the nymphal stages were determined on healthy and diseased celery (table 2). The males required from 41 to 54 days, with an average of 46.3 days, to complete the nymphal stages on healthy celery; and from 35 to 62 days, with an average of 48.5 days, on infected celery, or 2.2 days more than on healthy celery. To reach the adult stage, the females required from 43 to 55 days, with an average of 49.2 days, on healthy celery; and from 41 to 77 days, with an average of 50.3 days, on diseased celery, or an average of 1 day more than on healthy celery. The data show no significant differences in the length of the nymphal stages between leafhoppers reared on healthy celery and those reared on diseased plants.

All males passed through 5 molts on healthy celery. One male and one female passed through 6 molts, requiring 41 and 77 days, respectively, to complete the nymphal stages on infected celery plants.

Color of Nymphal Instars, Male and Female. The color of the first three instars is black with white markings on the head, thorax, and abdomen (plate 1, upper section). The bodies of the fourth and fifth instars are mottled brown and white (plate 1, upper section). A detailed description of the color pattern of the adult (plate 1, upper section) is given in the first paper of this issue (DeLong and Severin, 1950).

Mortality. A high mortality of the nymphs occurred when they were reared on healthy celery but was rare on diseased celery plants. Many nymphs died on healthy celery before or shortly after passing through the first molt.

¹ Received for publication July 6, 1948.

TABLE 2

DURATION OF PERIODS BETWEEN MOLTS IN NYMPHAL STADIA OF
TEXANANUS INCURVATUS REARED ON HEALTHY AND
INFECTED CELERY PLANTS

Date hatched	Duration of stadia, days						
	First instar	Second instar	Third instar	Fourth instar	Fifth instar	Sixth instar	Total
Reared on healthy celery plants							
Males							
August 17.....	15	7	9	6	17	..	54
September 29.....	11	7	4	7	15	..	44
September 30.....	9	9	4	5	14	..	41
Average.....	11.7	7.7	5.7	6.0	15.3	..	46.3
Females							
August 17.....	15	9	11	6	14	..	55
September 30.....	7	8	6	11	11	..	43
September 30.....	8	8	6	10	18	..	50
October 1.....	10	8	6	8	17	..	49
Average.....	10.0	8.2	7.2	8.7	15.0	..	49.2
Reared on infected celery plants							
Males							
July 4.....	6	7	7	6	9	..	35
July 4.....	9	8	6	7	6	..	36
August 11.....	12	8	6	11	18	..	55
August 12.....	12	7	5	10	14	..	48
August 12.....	13	11	11	8	15	..	58
August 14.....	16	6	9	11	13	..	55
August 17.....	10	8	7	8	13	..	46
August 17.....	11	10	6	10	11	..	48
August 17.....	11	10	6	10	25	..	62
August 18.....	11	6	9	10	13	..	49
September 20.....	6	6	6	7	12	4	41
Average.....	10.6	7.9	7.1	8.9	13.5	4	48.5
Females							
July 2.....	10	8	6	9	16	..	49
August 11.....	11	7	6	11	13	..	48
August 11.....	11	9	8	9	15	..	52
August 13.....	15	11	6	9	15	..	56
August 14.....	12	7	9	9	14	..	51
August 15.....	20	8	10	21	11	7	77
August 16.....	11	7	7	9	15	..	49
August 17.....	10	6	9	10	14	..	49
August 21.....	11	6	4	9	15	..	45
August 21.....	11	6	6	10	15	..	48
August 22.....	10	6	4	11	14	..	45
August 25.....	9	6	6	8	15	..	44
August 30.....	8	7	12	8	15	..	50
September 30.....	7	5	6	8	15	..	41
Average.....	11.1	7.1	7.1	10.0	14.4	7	50.3

An attempt was made to rear *Texananus incurvatus* on large healthy asters. Single females at the egg-laying stage, each with a male, were confined in cages, each enclosing 10 asters. Ten adults were reared on 1 aster, none on 9 asters. No difficulty was experienced in rearing this leafhopper on diseased asters.

PLANT SYMPTOMS INDUCED BY FEEDING OF NYMPHS

Single noninfective and infective nymphs feeding on healthy and infected celery, respectively, induced a chlorosis gradually spreading on the leaves upon which they fed.

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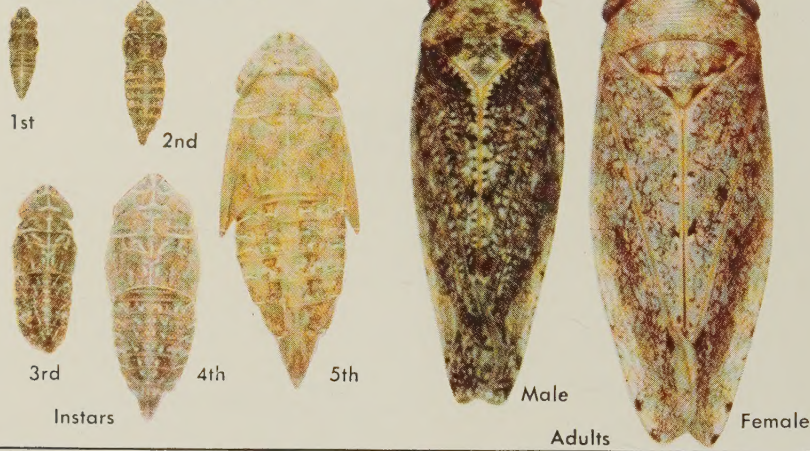
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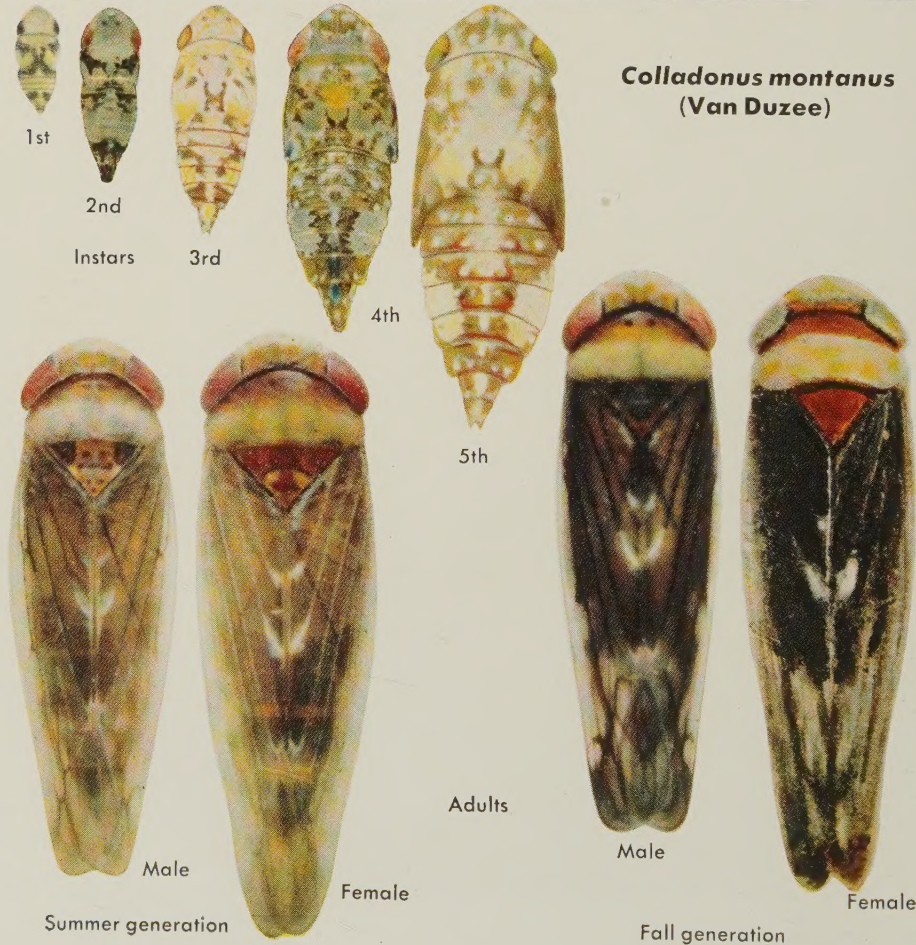
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PLATES

***Texananus incurvatus*
(Osborn and Lathrop)**

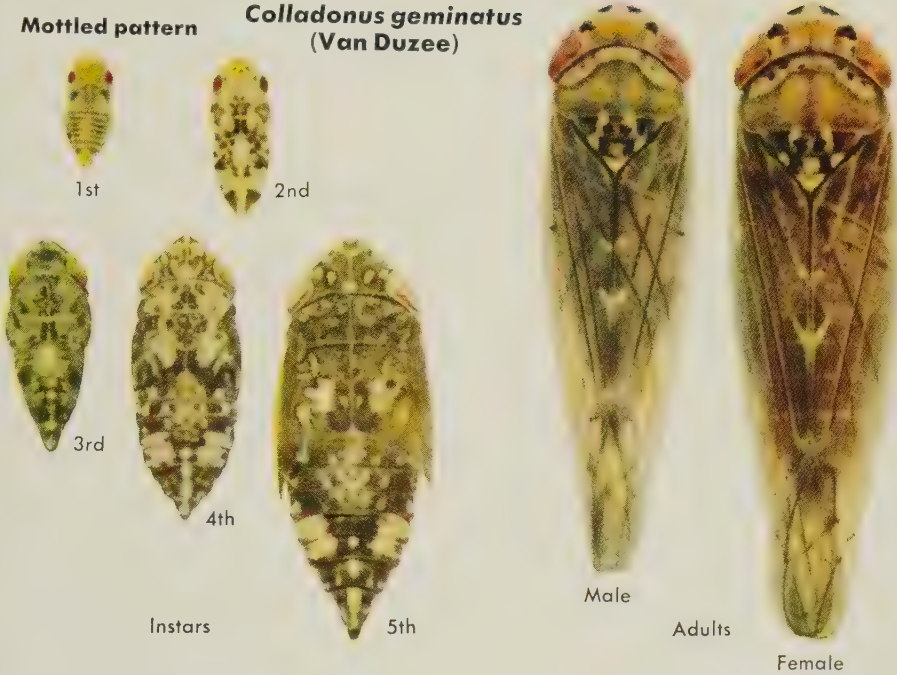


***Colladonus montanus*
(Van Duzee)**

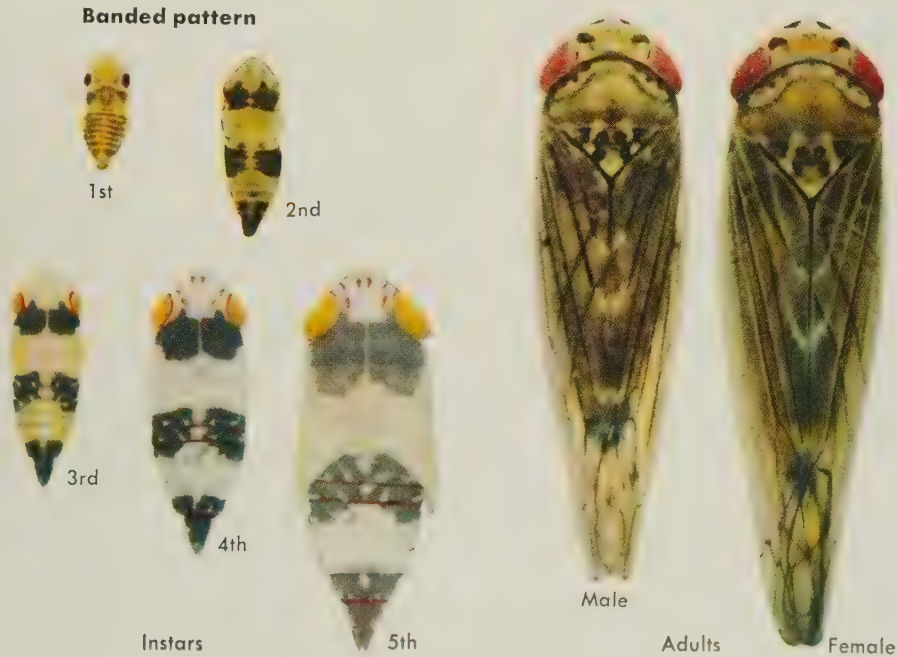


Mottled pattern

***Colladonus geminatus*
(Van Duzee)**



Banded pattern



COLLADONUS GEMINATUS AND C. MONTANUS

LIFE HISTORIES ON VIRUS-INFECTED AND ON HEALTHY PLANTS¹

HENRY H. P. SEVERIN and EDWARD C. KLOSTERMEYER²

A recent paper (Severin, 1946) presented evidence that nine species of leafhopper vectors completed the nymphal stages on celery or asters infected with the California aster-yellows virus. The adults died, however, when transferred to healthy celery or asters. In life-history studies, the average total duration of the nymphal stages of *Texananus lathropi* (Baker) and *T. spatulatus* (Van Duzee) was less on infected than on healthy celery. Although *T. spatulatus* is not a vector of curly top, it required less time to complete its nymphal stages on curly-top sugar beets than on healthy ones; the difference, however, was not statistically significant.

This paper compares the intervals or periods between molts and the total duration of the nymphal stages of the geminate leafhopper, *Colladonus geminatus* (Van Duzee), and the mountain leafhopper, *C. montanus* (Van Duzee), reared singly on healthy celery plants and on celery plants infected with California aster yellows. These two leafhopper species were selected because no nymph mortality occurred on either healthy or infected celery plants. Other aspects of the life-history studies include mating, preoviposition period, oviposition, egg periods, and egg-laying capacity. Measurements of various parts of the body were taken of each nymphal instar and of the adults.

METHODS AND EQUIPMENT

Life-history studies of the two leafhopper species were undertaken with nymphs hatched from eggs deposited in the petioles of infected and of healthy celery plants. A day or two before the hatching period, the petioles in which oviposition occurred were cut in pieces and placed in stender dishes, the bottoms of which were covered with moist filter paper. Each nymph that hatched was transferred by means of a pipette to a diseased or healthy celery seedling, each enclosed in a cage. Daily examinations were made to determine each molt. Whenever a nymph molted, the exuvia was removed from the plant. The pipette and cages used have been illustrated in a previous publication (Severin, 1930).

LIFE HISTORY OF GEMINATE LEAFHOPPER, *COLLADONUS GEMINATUS*

Mating. Two of 10 pairs of the adult leafhoppers were in coition 5 and 6 days, respectively, after they acquired the winged stage.

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Preoviposition Period. During February, under greenhouse conditions, an attempt was made to determine the number of days required before egg deposition began. A male and a female after the last molt were kept in each cage enclosing a celery plant; daily examinations were made to determine when egg-laying began. The preoviposition period required from 7 to 13 days after the females acquired the winged stage. The females of 2 pairs observed in coition each began to deposit eggs 12 days after the last molt, and 6 and 7 days, respectively, after mating.

TABLE 3
DURATION OF EGG PERIODS AND DAILY EMERGENCE
OF NYMPHS OF TWO SPECIES OF LEAFHOPPERS
FROM HEALTHY AND INFECTED
CELERY PLANTS

Days from oviposition to hatching	Eggs on healthy celery		Eggs on infected celery	
	Nymphs hatched	Percentage of total hatched	Nymphs hatched	Percentage of total hatched
Geminate leafhopper, <i>Colladonus geminatus</i> ; eggs deposited October 29-30				
14	1	1.1	20	6.6
15	4	4.3	33	11.0
16	27	29.0	86	28.6
17	27	29.0	82	27.3
18	26	27.9	55	18.3
19	5	5.3	14	4.6
20	3	3.2	8	2.6
21	0	0.0	2	0.6
Total	93	....	300	....
Mountain leafhopper, <i>Colladonus montanus</i> ; eggs deposited August 16-17				
13	0	0.0	2	5.2
14	25	31.6	15	40.5
15	32	41.0	4	10.8
16	20	25.3	0	0.0
17	2	2.5	13	35.1
18	0	0.0	2	5.2
19	0	0.0	1	2.7
Total	79	....	37	....

Oviposition. In the process of oviposition, the female makes incisions in the margin of the celery leaves with her ovipositor, sometimes below the epidermis of the blade, and also in the veins and petioles, where she embeds a single egg in each slitlike egg chamber. Although occasionally laid singly, the eggs usually are deposited several in a row in the margin of the celery leaves or in the petioles. On rare occasions some females—probably near the end of natural life—deposit eggs on the surface of the leaves.

Egg. Measurements of 5 eggs indicate that the length of the egg ranges from 0.98 to 1.05 mm, with an average of 1.02 mm; the width from 0.22 to 0.25 mm, with an average of 0.24 mm. The egg is translucent when first

deposited but during the embryonic development turns white. It is elongated, narrower at one end than at the other, the distinction between dorsal and ventral surfaces being indicated by a difference in curvature. Near the hatching period, the pink eyes of the embryo become visible.

Egg Periods. The egg periods were determined from eggs deposited during October. Females were confined in cages enclosing healthy and infected celery plants and were transferred daily to successive plants for a period of 2 to 3 days. The plants in which eggs were deposited were covered with cages and examined daily for the hatching of nymphs. Eggs deposited during 1 day hatched over a period of 8 days. A daily count of the nymphs hatched in each cage was taken. The egg periods, with the number and percentage of nymphs that hatched, are shown in table 3.

There were no marked differences in the percentages of the total nymphs hatched daily from eggs deposited in healthy and infected celery. The egg periods varied from 14 to 21 days with eggs deposited during October.

Hatching. The nymph, enclosed in the chorion and egg membranes, pushes out of the slitlike aperture of the egg chamber during the process of hatching. After its extrication from the eggshell and embryonic membranes, it remains suspended with the tip of the abdomen in the embryonic envelopes and with legs sprawled apart. When the exoskeleton hardens, the nymph crawls away and usually settles on the lower surface of the leaf to take its first meal.

Molting. Certain indications appear a day or two before the nymph molts. The body becomes distended, the membranous connections between the head and thorax, thorax and abdomen, and between the abdominal segments become greatly stretched, and the abdomen shows a rounding out. During the process of molting, the nymph inserts the setae into the tissue of the plant and firmly clasps the petiole or leaf with the claws. After molting, the nymph remains suspended with the tip of the abdomen in the exuvia and with legs sprawled apart. The adult is white in color after the last molt, and the wings expand rapidly. The elytra are held away from the lower wings until the exoskeleton hardens.

Color of Nymphal Instars and Adults. Recently hatched nymphs are white with pink compound eyes. Within a few hours after the molt, the bodies develop a faint color pattern, which becomes more pronounced a few days later. There are two nymphal color patterns (plate 2): one in which each instar is mottled with yellow and brown, and one in which each instar is marked with black bands on the thorax and some of the segments of the abdomen. There is no marked difference in the color patterns of male and female adults reared from mottled nymphs and of those reared from black-banded nymphs (plate 2).

Duration of Periods Between Molts. A comparison was made of the intervals or periods between molts and the total duration of the nymphal stages and egg periods of mottled and black-banded nymphs, reared singly on healthy and diseased celery plants (table 4). The males reared from mottled nymphs required 26.6 days to complete the nymphal stages on healthy celery and 24.0 days on infected celery; the females required 28.5 days on healthy celery and 29.6 days on infected celery. Of those reared from black-banded nymphs, one male required 27 days on healthy celery and two males an aver-

TABLE 4
DURATION OF EGG AND NYMPHAL STAGES OF TWO SPECIES OF
LEAFHOPPERS ON HEALTHY AND ON INFECTED
CELERY PLANTS

Date hatched	Duration of egg and nymphal stages, days							Total nymphal stages, days	Total egg period and nymphal stages, days
	Egg period	First instar	Second instar	Third instar	Fourth instar	Fifth instar	Sixth instar		
Males of geminate leafhopper, <i>Colladonus geminatus</i> , reared from mottled nymphs on healthy celery plants									
November 15.....	17	6	3	4	4	7	..	24	41
November 15.....	17	6	5	3	5	7	..	26	43
November 15.....	17	9	3	4	4	7	..	27	44
November 15.....	17	6	5	6	3	8	..	28	45
November 16.....	18	8	4	4	3	4	..	25	43
November 16.....	18	8	4	4	3	7	..	26	44
November 16.....	18	7	4	5	3	9	..	28	46
November 16.....	18	8	4	4	4	10	..	30	48
November 17.....	19	6	4	5	3	8	..	26	45
Average.....	17.6	7.1	4.0	4.3	3.5	7.4	..	26.6	44.3
Males of geminate leafhopper, <i>Colladonus geminatus</i> , reared from mottled nymphs on infected celery plants									
November 14.....	17	7	3	4	4	6	..	23	41
November 14.....	17	7	3	4	4	6	..	23	41
November 15.....	18	5	3	4	4	6	..	22	40
November 15.....	18	9	3	4	4	7	..	27	45
November 16.....	19	6	4	5	3	7	..	25	44
Average.....	17.8	6.8	3.2	4.2	3.8	6.4	..	24.0	42.2
Females of geminate leafhopper, <i>Colladonus geminatus</i> , reared from mottled nymphs on healthy celery plants									
November 15.....	17	7	3	4	5	7	..	26	43
November 15.....	17	8	4	3	6	6	..	29	46
November 15.....	17	8	5	6	3	8	..	30	47
November 16.....	18	6	5	4	4	9	..	28	46
November 16.....	18	7	5	4	4	8	..	28	46
November 17.....	19	5	5	4	4	9	..	27	46
November 17.....	19	7	4	4	3	14	..	32	51
Average.....	17.8	6.8	4.4	4.1	4.1	8.7	..	28.5	46.4
Females of geminate leafhopper, <i>Colladonus geminatus</i> , reared from mottled nymphs on infected celery plants									
October 23.....	15	8	4	5	5	7	..	29	44
October 23.....	15	10	5	4	5	7	..	31	46
October 23.....	15	7	8	4	5	9	..	33	48
October 23.....	16	8	5	5	4	7	..	28	44
October 25.....	17	7	5	5	6	6	..	29	46
November 14.....	17	7	5	3	5	8	..	28	45
Average.....	15.8	7.8	5.3	4.3	5.0	7.3	..	29.6	45.5
Male of geminate leafhopper, <i>Colladonus geminatus</i> , reared from black-banded nymphs on healthy celery plant									
November 17.....	19	6	4	4	5	8	..	27	46.0

TABLE 4—Continued

Date hatched	Duration of egg and nymphal stages, days							Total nymphal stages, days	Total egg period and nymphal stages, days
	Egg period	First instar	Second instar	Third instar	Fourth instar	Fifth instar	Sixth instar		
Males of geminate leafhopper, <i>Colladonus geminatus</i> , reared from black-banded nymphs on infected celery plants									
November 15.....	17	8	3	4	4	8	..	27	44
November 16.....	18	4	4	3	5	7	..	25	43
Average.....	17.5	6.0	3.5	3.5	4.5	7.5	..	26.0	43.5
Females of geminate leafhopper, <i>Colladonus geminatus</i> , reared from black-banded nymphs on healthy celery plants									
November 15.....	17	7	5	4	4	10	..	30	47
November 16.....	18	6	4	4	4	8	..	26	44
November 17.....	19	6	2	2	5	4	8	27	46
November 17.....	19	6	4	2	3	4	9	28	47
Average.....	18.2	6.2	3.7	3.0	4.0	6.5	8.5	25.2	46.0
Females of geminate leafhopper, <i>Colladonus geminatus</i> , reared from black-banded nymphs on infected celery plants									
October 23.....	15	8	4	4	5	8	..	29	44
October 25.....	17	7	5	6	4	8	..	30	47
November 15.....	17	6	3	4	4	7	..	24	41
November 16.....	18	6	4	4	4	8	..	26	44
Average.....	16.7	6.7	4.0	4.5	4.2	7.7	..	27.2	44.0
Males of mountain leafhopper, <i>Colladonus montanus</i> , reared from nymphs on healthy celery plants									
August 16.....	14	4	4	4	5	7	..	24	38
August 16.....	14	5	4	4	3	2	6	24	38
August 16.....	14	5	4	5	5	6	..	25	39
August 16.....	15	5	5	4	5	6	..	25	40
August 16.....	14	5	4	3	2	5	7	26	40
August 16.....	14	5	5	3	5	11	..	29	43
August 16.....	14	9	5	5	5	7	..	31	45
Average.....	14.1	5.4	4.4	4.0	4.3	6.3	6.5	26.3	40.4
Males of mountain leafhopper, <i>Colladonus montanus</i> , reared from nymphs on infected celery plants									
August 16.....	17	5	3	5	5	7	..	25	42
August 16.....	13	6	4	5	5	7	..	27	40
August 16.....	14	7	4	5	4	7	..	27	41
August 16.....	15	5	5	5	5	7	..	27	42
August 16.....	15	6	5	7	4	7	..	29	44
Average.....	14.8	5.8	4.2	5.4	4.7	7.0	..	27.0	41.8

Table concluded on next page.

TABLE 4—*Concluded*

Date hatched	Duration of egg and nymphal stages, days							Total nymphal stages, days	Total egg period and nymphal stages, days
	Egg period	First instar	Second instar	Third instar	Fourth instar	Fifth instar	Sixth instar		
Females of mountain leafhopper, <i>Colladonus montanus</i> , reared from nymphs on healthy celery plants									
August 16.....	14	5	4	2	4	5	7	27	41
August 16.....	15	5	5	5	2	2	8	27	42
August 16.....	14	5	5	6	5	8	..	29	43
Average.....	14.3	5.0	4.6	4.3	3.6	5.0	7.5	27.6	42.0
Females of mountain leafhopper, <i>Colladonus montanus</i> , reared from nymphs on infected celery plants									
August 16.....	17	6	4	4	5	8	..	26	43
August 16.....	14	6	4	6	5	8	..	29	43
August 16.....	14	7	5	6	5	7	..	30	44
August 16.....	17	5	6	6	8	9	..	34	51
Average.....	15.5	6.0	4.7	5.5	5.7	8.0	..	29.7	45.2

age of 26 days on infected celery; the females required 25.2 days on healthy celery and 27.2 days on infected celery. The data show no significant differences in the length of the total nymphal stages between those reared on healthy celery and those reared on diseased celery.

Two females reared on healthy celery passed through 6 molts; all other males and females molted 5 times.

Measurements of Nymphal Instars and Adults. Table 5 gives the average measurements of various parts of the body 1 day after hatching and 1 day after each molt for 5 nymphs, 5 males, and 5 females of *Colladonus geminatus*. Each instar can be determined from the range of measurements: the diameter of the head across the compound eyes, and the length of the head, thorax, and abdomen. Average measurements of the male and female leafhoppers show that the males are smaller than the females.

LIFE HISTORY OF MOUNTAIN LEAFHOPPER, *COLLADONUS MONTANUS*

Measurements of Nymphal Instars and Adults. The average measurements of various parts of the body 1 day after hatching and 1 day after each molt of 5 nymphs, 5 males, and 5 females are given in table 5. Each instar can be determined from the range of measurements: the diameter across the compound eyes, and the length of the head, thorax, and abdomen. The males are smaller than the females.

Mating. Three of 10 pairs of adults copulated 5 days after the leafhoppers acquired the winged stage.

Preoviposition Period. Daily observations were made to determine the number of days required by females before egg-laying begins. The preoviposition period of 10 females required from 12 to 20 days, with an average of

13.9 days. Three females, observed mating, began to deposit eggs 5, 13, and 18 days later, and 11, 15, and 18 days, respectively, after the last molt.

Oviposition. The process of oviposition is similar to that described for *Colladonus geminatus*.

Egg. Measurements of 5 eggs indicate that the length of the egg ranges from 0.98 to 1.10 mm, with an average of 1.05 mm; the width from 0.25 to 0.32 mm, with an average of 0.29 mm.

TABLE 5
AVERAGE MEASUREMENTS OF INSTARS AND ADULTS OF TWO
SPECIES OF LEAFHOPPERS

Nymphs and adults	Diameter of head across compound eyes, mm			Length of head, thorax, and abdomen, mm			Length of head to end of wings, mm		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Geminata leafhopper, <i>Colladonus geminatus</i>									
First instar.....	0.37	0.35	0.36	1.08	0.98	1.03	.....	.....	.....
Second instar.....	0.49	0.45	0.47	1.54	1.45	1.48	.....	.....	.....
Third instar.....	0.64	0.59	0.61	2.22	1.84	2.03	.....	.....	.....
Fourth instar.....	0.86	0.79	0.82	2.57	2.45	2.51	.....	.....	.....
Fifth instar.....	1.05	0.98	1.01	3.48	3.19	3.33	.....	.....	.....
Males.....	1.16	1.08	1.12	3.92	3.68	3.80	4.80	4.32	4.56
Females.....	1.32	1.24	1.28	4.32	4.08	4.20	5.08	4.92	5.00
Mountain leafhopper, <i>Colladonus montanus</i>									
First instar.....	0.35	0.33	0.34	1.05	1.01	1.03	.....	.....	.....
Second instar.....	0.49	0.47	0.48	1.62	1.49	1.55	.....	.....	.....
Third instar.....	0.64	0.61	0.62	2.08	2.01	2.04	.....	.....	.....
Fourth instar.....	0.79	0.74	0.76	2.45	2.37	2.41	.....	.....	.....
Fifth instar.....	1.04	1.00	1.02	3.60	3.24	3.42	.....	.....	.....
Males.....	1.12	1.08	1.10	3.92	3.64	3.78	4.20	4.04	4.12
Females.....	1.40	1.28	1.34	4.48	4.12	4.30	5.20	4.60	4.90

Egg-Laying Capacity. To determine how many eggs a single female deposits during her adult life, 1 female and 1 male after the last molt were confined in each cage enclosing a large healthy celery plant. The eggs were allowed to hatch; the total number of nymphs removed from each cage would equal the egg-laying capacity, provided that all of the eggs hatched. Since the nymphs and adults cause a rapid yellowing of the leaves, as reported in a previous paper (Severin, 1947), the female and male were transferred to a healthy plant whenever the celery became unfavorable as food. The nymphs were removed twice a month from each cage. The numbers that hatched from eggs deposited by each of 3 females were 289, 324, and 348, or an average of 320.

Egg Periods. The egg periods were determined from eggs deposited during August. Eggs deposited during 1 day hatched over a period of 7 days. The nymphs were removed daily from each cage and counted. The egg periods

with the number and percentages of nymphs that hatched are shown in table 3. The egg periods varied from 13 to 19 days.

Color of Nymphal Instars and Adults. The recently hatched nymph is white with pink compound eyes. Within a few hours after hatching, the body is yellow with black areas on the thorax and abdomen (plate 1). The color pattern of the second instar (plate 1) is similar to that of the first. The head, thorax, and abdomen of the third, fourth, and fifth instars are mottled yellow and pale brown (plate 1). The male and female of the summer generation are reddish brown, while the adults of the autumn generation are usually black (plate 1). The face is white or yellowish; a transverse reddish-brown band occurs between the compound eyes and a conspicuous yellow one, also transverse, occurs on the pronotum; the scutellum is reddish brown.

Duration of Periods Between Molts. The intervals or periods between molts (stages or stadia) in *Colladonus montanus* and the total nymphal stages are given in table 4. The average total duration of the nymphal stages of the males reared on healthy celery was 26.3 days and on infected celery, 27.0 days; and of the females reared on healthy celery, 27.6 days, and on infected celery, 29.7 days. The data show no significant differences in the duration of the nymphal stages between leafhoppers reared on healthy celery and those reared on diseased celery. The total duration of the nymphal stages is shorter for the males than for the females.

Four males reared on healthy celery passed through 6 molts; all other males and females molted 5 times.

Two Species Do Not Interbreed. Since the mottled nymphal instars (plate 1, lower section) of *Colladonus montanus* somewhat resemble those of *C. geminatus* (plate 2, upper section), an attempt was made to interbreed or cross the adults of the two leafhopper species. After the last molt 2 males and 2 lots of 25 males of *C. montanus* reared from mottled nymphs were confined in cages with the same number of female *C. geminatus* reared from mottled nymphs. The reverse cross was made with corresponding numbers of female *C. montanus* and male *C. geminatus*. A similar test was made with male and female *C. montanus* reared from mottled nymphs and kept in cages with adult *C. geminatus* reared from black-banded nymphs. No nymphs appeared in any of the cages. The males of the two species attempted to mate, but the females either kicked the males away or walked away themselves. The two species of leafhoppers did not interbreed.

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